A New Registered Cultivar "Natsukaze" of Guineagrass

By Hiroyasu SATO, Norihiro SHIMIZU*,
Hitoshi NAKAGAWA** and Kousuke NAKAJIMA***

Department of Grassland, Kyushu National Agricultural Experiment Station
(Nishigoshi, Kumamoto, 861-11 Japan)

Introduction

Guineagrass, *Panicum maximum* Jacq., is a widely spread native grass of tropical Africa. It has been introduced to many other tropical countries including Australia, South America, and East Asia in the late 19th century. In these countries, guineagrass attracted the attention of farmers and showed a rapid rate of increase in cultivation.

Here in Japan, it was first introduced in the late 1950's to the Kyushu National Agricultural Experiment Station, Nishigōshi, Kumamoto, and the Kagoshima Prefectural Agricultural Experiment Station, Ōsumi, Kagoshima. However, for some unknown reason, follow up evaluation tests were not completed.

In the late 1970's, *Panicum maximum* var. *trichoglume*, commonly known as green panic, was introduced from Australia to several experimental stations in southern Kyushu. This cultivar was soon recognized as an excellent annual grass for hay production, and practical production has spread to arable land mainly in southern Kyushu.

Although giant stargrass, pangolagrass, and rhodesgrass, which are well-known to be valuable, have been used extensively in the islands of Okinawa, guineagrass was not taken notice until 1970, because, at that time, there was a strong interest in creeping grasses, and guineagrass, a non-creeping perennial was overlooked. However, the introduction of guineagrass has become a subject of major interest in the Yaeyama islands (the southernmost district of Okinawa) where rhodesgrass has frequently been damaged by summer drought.

Under such a situation, the breeding of guineagrass in Japan started in close cooperation between the National Grassland Research Institute and the Kyushu National Agricultural Experiment Station.

As the result of their efforts, an outstanding new strain of guineagrass was developed and released in 1985 with the name "Natsukaze"[5,6].

Breeding procedures and characteristics of Natsukaze are briefly reported in this paper.

Breeding procedures and materials

In 1972 and 1973, S. Hojito of the National Grassland Research Institute, was sent to East Africa, supported by the Tropical Agriculture Research Center, for the purpose of plant introduction[1].

In 1974, guineagrass seeds of his collections, along with seeds imported from Republic of South Africa and the United States, were arranged and planted in the experimental field of the National Grassland

Present address:
* National Grassland Research Institute (Nishinasuno, Tochigi, 397-27 Japan)
** Okinawa Branch, Tropical Agriculture Research Center (Maesato, Ishigaki, Okinawa, 907 Japan)
*** National Institute of Agrobiological Resources (Tsukuba, Ibaraki, 305 Japan)

Research Institute to examine plant characteristics of the guineagrass, particularly the mode of reproduction (sexual reproduction or apomixis). Seeds of the first generation were obtained from 208 individual plants. On each plant, one spike was isolated by bagging, while the remaining spikes were left to open pollination. A total of 355 strains of the next generation, derived from the seeds obtained by open pollination and by bagging of 208 parental individuals were planted in rows with the ten plants for numbers of each strain. As the result of examination of leaf- and stem-hairs on individual plants of each strain, it was found out that several strains showed intra-strain variation of the hairs, indicating the possibility of the existence of strains produced by cross-pollination, inspite of the known fact that guineagrass is generally reproduced by apomixis. By examining the subsequent generations, it was ascertained that the intrastrain variation continued to exist in the progenies. Finally, four plants were selected as sexually pollinated clones[3] from all the strains tested. With these clones, open pollination and selection were repeated for three times. From them, the plants which showed potentially high productivity were selected, propagated by apomixis, and then they were subjected to yield trials and examination of their characteristics in the field of the Kyushu National Agricultural Experiment Station. Thus, a superior line named Kyushu No. 1 was selected and performance tests were carried out at 13 sites in warmer regions of Japan. At the same time, chemical composition of leaves and stems at each cutting stage was examined at the National Grassland Research Institute. An experiment to determine the feed value as hay was carried out using 4 heads of cattle at the Kyushu National Agricultural Experiment Station, Miyakonojō, Miyazaki Prefecture.

Results

1) Mode of reproduction

Natsukaze is the product of apomixis, similar to the case of normal guineagrass, although sexually reproduced plants were used as the breeding material. The mode of reproduction is discriminated by embryosac analysis[2] briefly outlined below.

Florets, having two fragments just appeared were fixed in Navashin's solution for 24 hr. They were then stored in a 70% ethanol solution until use. The florets were transferred into a cleaning solution; a mixture of lactic acid, chloral hydrate, phenol, eugenol and xylene (10:10:10:10:5 in volume) for 48 hr, or into the series of solution: ethanol, 100% ethanol, a mixture of ethanol and methyl salicylate (1:1), a mixture of ethanol and methyl salicylate (1:3) and 100% methyl salicylate, for 2 hr for each solution.

Microscopic observation of embryosac indicated that all the guineagrass strains conduct apomixis with 4 nuclei in an ovule. Colored guineagrass, however, was recognized to be sexually reproducing plants having 8 nuclei in an ovule (Table 1).

2) Morphological and agronomic characters

Table 2 shows morphological characteristics of Natsukaze as compared with those of green panic. One of the most remarkable features is great leaf width (more than 3 cm) compared with 1.8 cm of green panic. Its plant height is over 2.5 m; about 60 cm taller than green panic. Variation in culm length in the population at maturity is small. Stems are rather thick, 6.0 mm in diameter; about 2 mm wider than those of green panic. The heading date of Natsukaze is late July (2 weeks later than green panic) when sown late in April.

3) Growth

The most salient characters of Natsukaze is fast growth in the early stage (Table 3). On the 30th day after sowing, Natsukaze reached 37 cm in height, i.e., 6 cm and 15 cm taller than green panic and Gatton, respectively. On the 45th day, it attained 79 cm, in contrast to only 63 cm of green panic. On the 55th day (at the first cutting stage), it reached 138 cm in height compared with 116 cm of green panic. Its regrowth after

Table 1. Mode of reproduction of genus *Panicum* distinguished by means of embryosac analysis

Species and lines	No. of plants observed	No. of plants classified				Percentage of S-plants
		S	SA	AS	A	
P. maximum						
Natsukaze	48	7	5	8	28	15
B7-10	28	0	5	5	18	0
PI 290964	25	0	0	2	23	0
Tift Pm-3	63	0	0	0	63	0
Tift Pm-16	12	2	0	0	10	17
Tift Pm-23	16	3	0	1	12	19
Gatton	33	2	6	5	20	6
P. max. var. *trichoglume*						
Petrie	38	0	0	3	35	0
P. antidotale						
PI 315719	20	4	0	0	16	20
P. deustum						
PI 364951	33	0	0	5	28	0
P. coloratum var. *kabulabula*						
PI 253254	47	47	0	0	0	100
PI 284152	27	26	0	0	1	96
P. coloratum var. *makarikariense*						
PI 277963	21	19	0	0	2	90
PI 253249	13	13	0	0	0	100

S : Sexual reproduction (8 nuclei), A : Apomixis reproduction (4 nuclei),
SA : Polygerm and mixed S and A, S dominant, AS : Polygerm and mixed S and A, A dominant.

Table 2. Some morphological features of Natsukaze and other cultivars (1984)

Cultivars	Heading date	Culm length (cm)	Culm diameter (mm)	Panicle length (cm)	Leaf width (cm)
Natsukaze	July 27	222	6.0	39	3.2
Gatton	July 14	176	4.3	27	2.0
Green panic	July 12	155	4.1	29	1.8

Table 3. Growth (in cm of plant height) of Natsukaze in the initial growth stage, as compared with other cultivars (1983)

Cultivars	30 days*	45 days*	55 days*
Natsukaze	37	79	138
Gatton	22	63	109
Green panic	31	63	116

* After sowing.

cutting was the fastest among the guinea-grass cultivars tested.

4) Yields

The average of dry matter yields of Natsukaze at 13 experimental sites was 1.81 t/10 a (Table 4). This was 1.4 times that of green panic. The highest yield except that in Okinawa was 2.97 t/10 a (1.3 times that of green panic) in Tottori in 1981. The lowest yield was 0.78 t/10 a (1.4 times that of green panic) in Hiroshima in 1980. Fresh yields showed the same tendency as dry matter yields. In Kyushu, well suited for growing annual tropical grasses, Natsukaze yielded 0.96–2.43 t of dry matter at five experimental sites each year from 1981 to 1984. These yields were 1.28–1.44 times that of green panic. In Okinawa, the most suitable for growing tropical grasses in grassland, Natsukaze markedly

Table 4. Dry matter yields (kg/10a) at 13 sites

Place	Year	Natsukaze (A)	Green panic (B)	A/B
Mainland				
Tochigi	'79	154	102	151%
Toyama	'80—82	145	114	127
Aichi	'78—84	157	97	169
Hyogo	'80—83	215	139	156
Tottori	'81	297	224	133
Hiroshima	'80—81	104	93	119
Kagawa	'83—84	198	164	125
Kyushu isl.				
Fukuoka	'81	112	83	135
Kumamoto	'82—84	220	167	131
Oita	'83—84	184	116	160
Miyazaki	'83—84	122	103	126
Kagoshima	'82—84	183	141	131
Okinawa	'82	337	251	134
Mean		181	132	141

Table 5. Dry matter yields (kg/10a) in three years, 1982—1984, in Okinawa

Cultivars	1st year	2nd year	3rd year	Total
Natsukaze	337	303	303	943
Gatton	271	402	362	1,035
Green panic	251	330	331	912

outyielded green panic and other cultivars or lines in the first year. However, in the succeeding years the yield of Natsukaze decreased (Table 5), showing that Natsukaze is less persistent than other guineagrass cultivars.

5) Seed setting

Heading of Natsukaze begins in late July when sown in the middle of May. The heading occurs uniformly at about the same time in the population. Seeds shed easily before harvest. The shed seeds include fully-ripened seeds at the rate much higher than the rate observed with seeds remaining on pedicels.

Potential seed yield and fertility were examined by stripping all the seeds off panicles, which were clipped at a four days' interval after the shedding began.

As shown in Table 6, the seed-shedding began about two weeks after the first heading occurred and the proportion of ripened seeds reached a peak 15 to 18 days after shedding began. The practical seed yield obtained by row seeding was 23–31 kg/10 a for Natsukaze (from two harvests), while green panic showed 4–9 kg/10 a of seed yield, although green panic was adversely influenced by the weather. There were no remarkable differences in the amount of seeds sown.

Table 6. Result of the test to examine potential seed yields of Natsukaze (1984)

Date of harvest	Ripened seeds (%)	Weight of seeds (g)	Seed yield (g/a)
Aug. 3	5.5	0.986	3
7	15.6	1.104	63
11	31.9	1.167	319
15	44.3	1.125	620
18	72.0	1.116	571
24	17.8	1.061	143
29	17.8	1.122	70
Sept. 4	8.9	0.995	1

Plot size: 9.6m^2 in a randomized block design with two replications, spacing of plants, 30×60cm.

6) Resistant to root knot nematodes

According to the Nematode Laboratory, the Kyushu National Agricultural Experiment Station[4], four kinds of nematodes were used to test the effect of several antagonistic crops (Table 7). As far as this experiment is concerned, Natsukaze is very effective in suppressing three kinds of root knot nematodes.

7) Nutritive value and paratability

Chemical composition of leaves and stems of Natsukaze plants was examined at the National Grassland Research Institute. It differs only slightly from that of green panic and Gatton. However, since the proportion (in weight) of leaves (with high protein content) to stems is higher in Natsukaze than that of green panic, Natsukaze gave higher crude protein yield per unit area than did green panic.

Conclusion

Based on the agronomic characteristics and

Table 7. Effect of antagonistic plants on nematodes

Kinds of plant and cv.	Southern root knot nematoda	Japanese root knot nematoda	Northern root knot nematoda	Coffee root lesion nematoda
Guineagrass Natsukaze	◎	◎	◎	◎
Green panic Petrie	◎	◎	◎	◎
Broom corn	○	○	◎	×
Groundnut Chiba hanritsu	◎	◎	×	◎
Oriental senna	○	◎	◎	×
Crotalaria spectabilis	◎	◎	◎	×
Siratro	◎	◎	○	×
Stizolobium sp.	○	×	◎	×
French marigold	◎	◎	×	◎
Mexican tea	○	×	◎	◎

◎ : Fffective in suppressing population density of nematoda.
○ : No apparent effect or slightly effective in reducing the population.
× : Increased the population density.

Table 8. Nutritive components at four cuttings (%) (1984)

Compo-nents	Plant parts	1st cut		2nd cut		3rd cut		4th cut		Mean	
		NK	GP	NK	GP	NK	GP	NK	GP	NK	GP
CP	Leaf	22.3	22.1	19.1	19.1	18.4	19.3	21.7	21.8	20.4	20.7
	Stem	16.4	14.7	10.4	10.3	8.4	10.3	10.3	8.9	11.4	11.1
CFa	Leaf	2.5	2.6	4.2	3.5	3.3	2.9	3.8	3.4	3.4	3.1
	Stem	1.6	1.6	1.4	1.3	1.1	1.4	1.4	1.4	1.3	1.4
CFi	Leaf	26.9	27.0	27.4	28.3	27.7	28.7	21.7	23.7	25.9	26.9
	Stem	31.9	33.2	39.2	39.6	43.8	42.8	40.8	42.2	38.9	39.5
NFE	Leaf	35.7	36.5	36.8	37.6	37.5	37.4	37.5	38.8	36.9	37.6
	Stem	33.1	33.8	37.4	37.7	36.7	34.8	37.9	37.1	36.3	35.9
CA	Leaf	12.6	11.8	12.5	11.5	13.1	11.2	15.4	12.3	13.4	11.7
	Stem	17.0	16.7	11.7	11.2	10.1	10.7	9.6	10.4	12.1	12.3

NK : Natsukaze, GP : Green panic.
CP : Crude protein, CFa : Crude fat, CFi : Crude fiber, NFE : Nitrogen-free extract, CA : Crude ash.

performance of Natsukaze, it can be concluded that Natsukaze deserves wide utilization as an annual summer grass to be grown on arable land in Kyushu and other warm regions of Japan with the exception of Okinawa.

In Okinawa, Natsukaze grows well in the first year, but it shows a little less persistency than other cultivars in the succeeding years. It is necessary to breed a new cultivar to be grown in permanent pastures.

One of the most important characters required for the tropical grass to be planted to arable land as an annual grass, is the ability to produce high forage yields. Rhodesgrass and green panic, which are the most common tropical grasses cultivated in the arable land as an annual grass, can produce 1.0 to 1.3 t of dry matter/10 a with two or three cuttings in six months of their growing season. In this experiment, green panic yielded an average of 1.32 t of dry matter/10 a, whereas Natsukaze yielded 1.81 t/10 a; 1.4 times that of green panic.

Table 9. Proportion of leaf weight to plant weight harvested

Cultivar	Percentage of leaf weight at			
	1st cut	2nd cut	3rd cut	4th cut
Natsukaze	67	52	42	27
Gatton	65	47	38	42
Green panic	62	45	28	29

Natsukaze was ascertained to be resistant to root knot nematodes widely distributed in upland fields of soybean, sweet potato, tobacco etc. and kitchen gardens. It also tends to reduce the population of root knot nematodes in the soil. Natsukaze will be utilized as not only forage grass but also a cleaning crop for other crop fields.

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Summary

Natsukaze, a guineagrass cultivar, was developed in cooperation between the National Grassland Research Institute and Kyushu National Agricultural Experiment Station, and released in 1985. It is the first guineagrass cultivar bred in Japan. Almost all types of guineagrass perform apomixis, but at the first step of our breeding work, four plants derived from sexual reproduction were found out. Open pollination and selection were repeated three times using these plants. A breeding strain superior in agronomic characters was chosen and fixed by apomixis. Then, its characteristics, regional adaptation and so on were examined by a number of tests. Natsukaze is larger and more robust in plant type, showing more than 2.5 m of height and wide leaves. The average of dry matter yield in 13 sites for a year period was over 1.8 t/10 a, compared with 1.3 t of green panic. Although somewhat less persistency, Natsukaze can be used widely as an annual forage grass for hay production in arable land. In addition, Natsukaze demonstrated high resistance to root knot nematodes.

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